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ABSTRACT

The purpose of this paper is to improve knowledge of the interaction between the learner, the teaching arrangement, and the content. For practical purposes the combination of the teaching arrangement and the content has been called the task, as these cannot successfully be treated separately in the teaching-learning process. Through analysis of pupil-task interactions we should be able to discover relationships between the pupil and the task which are crucial to the outcomes of learning in terms of both achievement and attitudes to the task at hand. Different research approaches are classified which have contributed to present understanding of the learner-task interaction. The basic criterion for selection of research approaches has been the interactive character of the research effort as well as its heuristic value. A set of task dimensions to be observed are extracted from empirical research on learner-task interaction. These are: goals, evaluative criteria, structure, complexity, time constraints, and incentive value. Because these dimensions cannot be isolated from social and cultural processes, the study of learner-task interactions cannot be studied only in terms of individual and task characteristics. (HV)

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ANALYSES OF PEDAGOGICAL PROCESSES IN THE VOCATIONAL BRANCH OF UPPER SECONDARY SCHOOL

Approaches to the analysis of learner-task interactions and some implications for the study of pedagogical processes

Gunnar Stangvik

No 49 2 January 1976

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P R O J E C T Y P

Report No. 7

APPROACHES TO THE ANALYSIS OF LEARNER-TASK INTERACTIONS AND SOME IMPLICATIONS FOR THE STUDY OF PEDAGOGICAL PROCESSES

No 49

Gothenburg, January 1976

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CONTENTS

		Page
1	INTRODUCTION	1
2	THE CONTEXT OF TEACHING	4
2.1	The interrelated character of the task dimensions	4
2.2	The totality of the system of teaching	4
2.3	The multidimensionality of teaching	6
3	APPROACHES RELEVANT TO THE STUDY OF LEARNER-TASK INTERACTIONS	9
3.1	Cognitive-oriented paradigms	10
3.1.1	The ability-skill paradigm	10
3.1.2	The Aptitude Treatment Interaction (ATI) paradigm	12
3.1.3	Some comments on the preceding paradigms	14
3.1.4	The learning structure paradigm	16
3.1.5	The learning process paradigm	17
3.1.6	The behaviour analysis paradigm	18
3.1.7	The developmental tasks paradigm	19
3.2	Personality-oriented paradigms	20
3.2.1	The success-failure paradigm	20
3.2.2	The approach-avoidance paradigm	21
3.2.3	The anxiety-task paradigm	22
3.2.4	The locus of control paradigm	23
4	A SUMMARY OF PARADIGMS AND SOME TENTATIVE IMPLICATIONS	23
4.1	Cognitive-oriented paradigms	23
4.2	Personality-oriented paradigms	25
5	TASK DIMENSIONS RELEVANT TO THE ANALYSIS OF TEACHING AND LEARNING	27
5.1	Goals	27
5.2	Feed-back and the criteria of evaluation	27
5.3	Structure	28
5.4	Complexity	28
5.5	Time constraints	29
5.6	Incentive value	29
5.7	Conclusions	29
6	SOME GENERAL IMPLICATIONS FOR THE STUDY OF PEDAGOGICAL PROCESSES	29
	References	34

APPROACHES TO THE ANALYSIS OF LEARNER-TASK INTERACTIONS AND SOME IMPLICATIONS FOR THE STUDY OF PEDAGOGICAL PROCESSES

1 INTRODUCTION

This paper is initiated by a search for a sound theoretical foundation for an action research project in vocational schools. The purpose of this research is to get a firm grasp on the problems experienced by pupils and teachers and to find strategies to solve these problems (Nilsson 1975a). To coordinate the research effort a preliminary model for problem analysis was developed by the leader of the research project together with the present author (cf Nilsson 1975c, Nilsson & Stangvik 1975). Some important aspects of this model should be mentioned.

First, the problems which confront pupils and teachers in vocational schools are results of complex interactions between pupil characteristics, content, and teaching variables and they should therefore be plotted against the whole matrix of these variables. Secondly, an important assumption of the model is that the problems experienced by pupils and teachers are functionally related to structural aspects of the teaching environment. To solve the problems of teaching these functional relationships have to be made explicit. Thirdly, these functional relationships may for practical purposes be thought of as requirements. They are the objective and subjective manifestations of functional relations between pupil characteristic and teaching variables. Finally, the retrospective character of the model must be mentioned. Requirements may be objectively defined, as in the requirement of reading skills as a necessary prerequisite for doing a work operation, or they may be subjectively defined in terms of perceived requirements. If these requirements are pinpointed we should be able to work backwards to uncover the functional relationships and to restructure the teaching process so that the requirements may be put on a level less obstructive to learning. The generative assumption of the preliminary model

should be emphasized. The implication of this aspect of the model is that the problems experienced in the teaching process are to a great degree produced by the way teaching is arranged for the specific group of learners. Trying to analyse and to restructure teaching on these holistic grounds was deemed necessary for several reasons: 1) The perception of problems by the agents in the context of teaching is based on the perception of this context as a gestalt. To take part of their experience is to understand the specific relations between parts and wholes. 2) Even on the objective level the contextual and interrelated character of problems should be taken into consideration by the model. 3) The model should make sure that teaching is not based on general ability assumptions of pupil capabilities and that the interaction of pupil capabilities with the teaching arrangement is fully realized. 4) This holistic model may also be an important tool to do away with the idea of the grand method suited to all pupils and to develop more flexible teaching arrangements and attitudes to teaching.

The purpose of the present paper is to improve knowledge of the interaction between the learner, the teaching arrangement and the content. For practical purposes the combination of the teaching arrangement and the content has been called the task, as these cannot successfully be treated separately in the teaching-learning process. Through analysis of pupil-task interactions we should be able to discover relationships between the pupil and the task which are crucical to the outcomes of learning in terms of both achievement and attitudes to the task at hand. It will be pointed out later that these attitudes may determine subsequent achievement. In the teaching-learning process pupils are confronted with a vast array of tasks. These vary according to type and structure of content, relationships to other tasks, modes of presentation, and so on. Subtle variations in learning task variables may result in new requirements for the learner. Thus, a model of learner-task interaction should be based on the specification of task variables relative to the

characteristics of the learner. Such a model could serve as an important vehicle in educational decision making. Defining tasks in terms of the psychological structures of the learner would seem to have important implications for the ordering and sequencing of tasks, modes of presentation and selection, and adaption of the teaching material. If tasks could be described in terms of psychological differences between learners this could also have important bearings on thinking concerning individualised instruction.

In the following I have tried to classify different research approaches which have contributed to present understanding of the learner-task interaction. The basic criterion for selection of research approaches has been the interactive character of the research effort as well as its heuristic value.

The specific context of teaching imposes restrictions on learning. The content as well as the method of learning is defined by the values of the social structure in which the teaching takes place. These values determine the physical and symbolic setting of the learner-task interactions. Hence, requirements cannot be understood only in terms of individual and content characteristics.

In the present paper a set of task dimensions to be observed are extracted from empirical research on learner-task interaction. These are: goals, evaluative criteria, structure, complexity, time constraints and incentive value. It is important to keep in mind that these dimensions cannot be isolated from social and cultural processes. Hence, the study of learner-task interactions cannot be studied only in terms of individual and task characteristics. The following analysis will make that clear.

2 THE CONTEXT OF TEACHING

2.1 The interrelated character of the task dimensions

It has been argued that the content of learning cannot successfully be separated from the context in which the learning is taking place.

Consequently, the character of the relationship between this context and the learning relevant task dimensions should be properly established. The specific character of this relationship cannot be understood without taking into account the relationship between structural conditions inside and outside the classroom. These structural conditions may be thought of as restrictions on the teaching-learning relationship which help to determine its specific character.

The strength of this line of thought is that the holistic character of the teaching process is underscored. Changes in some parts of the system produce changes in the whole system. The gestalt character of educational phenomena as they are perceived by the agents of the teaching process has already been pointed out. The same type of conceptualisation should be applied when teaching is studied on objective grounds. The important thing is that the teaching-learning process may be studied on one level as an unrelated system of parts and wholes. On another level it may be seen as a part of a broader system dependent upon structural characteristics of the society as a whole - in which the teaching-learning process is taking place. The implication is that the non-reductive and interrelated character of the learning process should be considered.

2.2 The totality of the system of teaching

The totality of the system of teaching may be studied from the point of view of system theory as well as from a

structuralistic point of view. Since the structural conditions of teaching are perceived and structured on a cognitive level by the agents in the teaching process, these cognitions may affect the development of their teaching and learning strategies. Analysis of teaching should therefore include data concerning these cognitive structures. Referring to research by Dahllöf and Lundgren, Lago and Lundblad (1974 p 1-2) classify three types of pedagogical frames: organisational, curricular and time frames. These are thought of as measurable restrictions on the teaching process. If the time available is not sufficient to reach a goal in a specific class (the composition of the class according to individual differences in time needed may be considered a new restriction) the teacher may adopt different strategies: a) he may lower the goal, b) he may drop certain parts of the content and c) he may leave some pupils behind. The strategy decided upon is dependent upon: a) the teacher's subjective interpretation of the pedagogical frames, b) the teacher's conception of his role, and c) the pattern of teaching. This kind of research seems to indicate that the relationship between teaching and learning should be studied from a system theoretical and a structuralistic point of view, emphasizing the totality of the teaching process. Reviewing research on teaching, Gustafsson (1975) pointed out the reductionistic character of previous research which mainly had attempted to establish relations between elements in the teaching process in a mechanistic way by means of statistical methods or by reducing the teaching process to a question of the psychology of learning. Taking into consideration the complexity of teaching Gustafsson recommended a rational model which is based on the idea that teaching is a logical sequence of actions aiming towards certain goals (Gustafsson op cit, p 28). The intentional character of this model is pointed out. In the rational model the interrelated character of the elements of the teaching process is underscored and the purpose of the research is to establish the functional relationship between these elements. According to Gustafs-

son (op cit p 33-47) the system theory proposed by Dahllöf, (ref) based on the three components, frame factors, teaching process and outcome, is too static. Gustafsson feels that something important is needed. "Within this system theoretical approach we find it interesting to use the structuralistic epistemology when interpreting the process" (Gustafsson op cit p 36).

The key concepts of this epistemology are totality, transformation and self regulation. From a structuralistic point of view the foci of interest are the rules which are adopted within the pedagogical frames. To uncover these rules and their implicit behavioural structures teaching should be studied as a series of logical and sequential processes. It seems reasonable to expect that one important way for studying the logic of the teaching processes is to study them in terms of their content. Some important conclusions may finally be drawn:

1) Teaching processes are an interrelated series of events determined by measurable aspects of the teaching environment.

2) Teaching decisions and strategies are based on subjective interpretations and structuring of the framing conditions.

2.3 The multidimensionality of teaching

When teaching is studied from the preceding points of view the multidimensionality of classroom processes becomes apparent.

From a socioanthropological point of view, the plurality of the functions of teaching may be seen as implicit in the process itself. The character of the teaching process is, according to this line of thought, ritualistic, with rules governing the process to a great degree out of the reach of the agents in the process. They are seen as produced by the structural conditions of teaching. Analysing teaching processes from this perspective Callawaert and Nilsson (1975) distinguished four implicit functions of

teaching of the lecture type. These were:

1) Control, i.e., the teacher has to control the behaviour of the class to perform the lecture.

2) Isolation, i.e., the teacher has to interact selectively to control and to evaluate. The selective interaction of the teacher in turn produces new types of behaviours in groups with whom the teacher has not interacted.

3) Interaction balance, i.e., the teacher has to balance the interaction of the pupils to permit transmission of his message.

4) Evaluation, i.e., the teacher strives to evaluate the pupils during the process. The evaluation function increases the importance of the controlling, isolating and balancing functions.

These functions are not objectively defined. They are, according to Callawaert and Nilsson (op cit, p 143), operational goals built into the system by the frames and the resources of the system. To explain why these functions are performed in teaching even though they may be detrimental to effective learning, we shall, according to the above authors, have to take into account the kind of purposes that are fulfilled by them.

Callawaert and Nilsson (op cit p 142) draw attention to two important purposes: First, the functions contribute to the perpetuation of the system itself, and secondly, they contribute to the perpetuation of society. The validity of this kind of reasoning was shown rather dramatically in a minor process by Johansson et al (1975).

These researchers found that in teaching mathematics, teachers interacted frequently with pupils whose behaviours were disruptive, irrespective of their level of knowledge in mathematics, and that passive pupils with learning difficulties experienced the least amount of interaction. As Callawaert and Nilsson point

out, the teaching-learning process should also be interpreted in terms of its perpetuative functions. By this conceptualisation the school system is understood as an interrelated part of society as a whole. In order to comprehend the teaching-learning process we shall have to understand the structural problems of society. The relation between the perpetuative character of the school system and the political economy has become a focus of interest lately. These general reproductive functions are outlined by Masuch (1974 p 21). These are:

1) Economic perpetuation, i.e., the school system should produce the necessary amount and type of manpower.

2) Political perpetuation or socialisation, i.e., the school system should reproduce a public conscience which is compatible with the type of society of which the system is a part.

3) The school system should perpetuate itself. Educating its own manpower ensures that the school system itself develops harmoniously with the rest of society.

Furthermore, Masuch (op cit p 37-78) analysed the perpetuative functions of the school system in terms of the structure of the working processes. He distinguished three types of functions that need to be perpetuated within industrial capitalism. These were: 1) Intensity qualification, i.e., assiduity persistence, precision and reliability. 2) Productive qualifications, i.e., ability and work experience. 3) Innovative qualifications or scientific qualifications, i.e., the ability to organise work in logical and scientific ways. Masuch asserts that the accumulation of capital in modern capitalism is primarily dependent on the reproduction of intensity and innovative qualifications. According to Masuch (op cit p 65) the perpetuative functions of the school materialise in the conception of the role. If the pupil does not adapt to the role expectations in the school system, his

competitive ability on the labour market is threatened. Role behaviour and role expectation are responses to the framing conditions of the school system. According to this, the functional relationship between the school system and society at large may be studied in terms of role behaviours and role expectations. Huisken (1972 p 210-219) analyses further the relationship between political economy and the school system and argues that the didactical and institutional theories adopted by the school system are functionally related to the political economy. Technological and cybernetical principles implying "Zeitminimalisierung" and "Lehrmaximierung" are applied to the school system to increase its accountability (cf Larsen 1974, p 27-28). These contextual aspects of teaching are of vital importance for the interpretation of the teaching processes.

3 APPROACHES RELEVANT TO THE STUDY OF LEARNER-TASK INTERACTIONS

It is not the purpose of this paper to give a comprehensive review of research strategies which have been applied to the study of learning tasks. The approaches which are described here have been selected because they have implications for the model discussed earlier. All these approaches have one thing in common: They describe tasks in terms of present and antecedent conditions of the learner. By doing this they contribute to an understanding of the requirements of the tasks. A distinction is made between cognitive-oriented and personality-oriented research paradigms. This distinction seems reasonably valid when the variables of the paradigms are seen in the light of traditional classifications of variables. Referring to learning processes, however, the distinction may be rather problematic, as affective and cognitive dimensions of the learning process can only be separated on a theoretical level. In actual learning situations the person is interacting with the task as a total personality. In this interaction tasks

are conceptualised emotionally as well as cognitively. It could also be noted that the different approaches have their point of departure in different problem areas within teaching and learning, such as individual differences, learning, and developmental psychology.

3.1 Cognitive-oriented paradigms

3.1.1 The ability-skill paradigm. The basic assumption of this paradigm is that skills involved in complex activities can be described in terms of more basic abilities. Thus, these abilities may be considered as descriptive parameters of the learning process. Skill refers in this paradigm to the level of proficiency on a specific task or group of tasks, and ability refers to a general trait of the individual which has been inferred from certain response consistencies. It should be mentioned that the ability-skill distinction is by no means without its problems. Stake (Glaser 1967 p 4-5) investigated individual differences in certain learning tasks and found indications that learning abilities may to a great extent be specific to the task at hand. Besides the positive correlations between aptitude tests and learning parameters he found 2 memory-task factors, a numerical-task learning factor, and a concentration factor. In a later study Duncanson (Glaser op cit p 5) was able to isolate 3 learning factors (concept formation factor, verbal, and non-verbal learning factors) independent of ability factors. The limited validity of general ability measures in predicting outcomes in different learning tasks and the discovery of task specific factors support the interaction model of the learner-task relationship.

Programmatic research within the ability-skill paradigm in motor learning has been done by Fleishman and his collaborators (Fleishman 1967 p 165-191). By extensive use of factor analysis they have tried to define the fewest independent ability categories which might be most useful and meaningful in describing the widest

variety of tasks. Based on more than 200 studies Fleishman extracted 19 independent factors. Furthermore, Fleishman has been able to show that a) the particular combination of abilities contributing to performance changes as practice continues; b) the changes are progressive and systematic and eventually become stabilised; c) the contribution of "non-motor" abilities, which may play a role in early learning, decrease systematically with practice relative to motor abilities; and d) there is an increase in a factor specific to the task itself. By studying ability-task interactions experimentally Fleishman and his collaborators were able to build up a body of principles regarding task requirements. Task requirements were analysed by varying tasks along certain physical dimensions, and by administering the tasks to groups of subjects who also received a series of reference tasks known to tap certain more generalised abilities (eg "spatial orientation", "control precision", certain cognitive abilities). Ability requirements were specified by correlations between reference and criterion tasks. Using these techniques Fleishman has been able to show how changes of training conditions may change the ability requirements of tasks from "perceptual speed" to two other factors, "spatial orientation" and "response orientation". The ability-skill paradigm has also been applied to the study of more complex learning tasks. Käärriäinen (1970) administered 17 carefully selected factor tests to a mentally retarded sample. Four factors were extracted: "perceptual", "psychomotor", "memory-quantitative", and "verbal". Factor scores for each of the factors were correlated with results in a reading program. The results of the study showed that achievement in the reading program could best be predicted from scores on the perceptual factor. Working within the same framework, Nilsson (1975b) showed that only a minor part of the achievement variance in a training program for auto-mechanics could be explained by traditional intelligence tests. Tentatively, however, the regression analysis suggested an interaction between task variables and characteristics of the learner by

showing that a) scores on the verbal subtest accounted for a relatively greater proportion of the variance of the subtasks demanding cognitive skills than did scores on the other subtasks, b) scores on the verbal subtest accounted for a relatively greater proportion of variance in earlier stages of learning than in later stages of learning, c) spatial subtests accounted for relatively greater proportion of variance in later stages of learning than in earlier stages.

The ability-skill paradigm is consistent with an information processing model of human learning. In this model abilities can be thought of as "capacities to utilise different kinds of information" (Fleishman op cit p 170). Thus individuals who are especially good at using certain types of spatial information make rapid progress in early stages of learning certain kinds of motor tasks while individuals sensitive in proprioceptive areas do better in tasks requiring precise motor control. Thus there seems to be a preferential relation between tasks and individual differences in abilities.

3.1.2 The Aptitude Treatment Interaction (ATI) paradigm. This paradigm has been developed within the ability-skill tradition. In the ability-skill paradigm the primary purpose has been to do taxonomic task analyses in terms of abilities. Information about ability requirements in different stages of training may then be used to change training conditions in a very general way. The purpose of research within the ATI (aptitude-treatment-interaction) paradigm, on the other hand, is to find the optimum relationship between individual differences and treatment conditions.

The basic assumption of this paradigm is that there is no general method suitable for all pupils. The primary aim of ATI-research has been to establish the kinds of treatment conditions necessary for pupils of different composite abilities to reach the same goals. The focus of this research is consequently not on the discovery of main

effects of different treatments, but on the interaction between treatments and ability variables. Especially interesting is interaction of the disordinal kind implying, for example, that at a certain level of the ability difference variable the effects of two different methods (A and B) are reversed. Under the condition of disordinal interaction the prescriptive rule could be: teach pupils below a certain point of the difference variable with method A and pupils above that point with method B, (see Gustafsson 1975 p 2). Programmatic research within the ATI-paradigm has been done by Gustafsson (1971, 1974a, 1974b, 1975). The results from this line of research may be considered rather meager in terms of rules for educational decision making (Gustafsson 1975 p 9), but the paradigm certainly is important heuristically. Since the adaption of treatment to differences between learners is a goal of teaching the ATI paradigm has face validity. The utility of the paradigm to task analysis is exemplified by Gustafsson (1974a p 86-111). Gustafsson administered achievement tests to two groups of subjects who had been exposed to two educational treatments differing only in the quantity of illustrations and texts. By analysing regression coefficients of ability variables on the achievement tests, he was able to show that "when it is possible to extract the needed information from the illustration the high figural ability pupil will profit" (Gustafsson 1974a p 111). In the ATI language this is termed a <u>preferential interaction</u>; that is the learning task is channelled (illustrations) in the professed modality of the learner (high figural ability). The purpose of this conceptualisation is to link the requirements of the tasks to the differential ability patterns of learners. In interaction of the preferential type the correlations between ability and achievement in the particular treatment will be high. When the correlations are low in a particular treatment, however, we may talk of <u>compensatory interaction</u>. If the correlations between figural ability variables and achievement within the pictorial treatment had been low in the example referred to above this could mean that the illustrations could have had a compensating effect on the learners low in figural ability. A third kind of interaction

ought also to be mentioned - the remedial interaction. This interaction deals with task-specific prerequisites for learning in cases where learning at a certain level is strongly dependent on mastery of earlier units. The possibility of finding this kind of interaction lies in modification of task-specific abilities or remedial training. These concepts which have a rather high explanatory value in the ATI paradigm are treated in Härnqvist (1973 p 12) and in Gustafsson (1974 p 6-7; 1975 p 6-7).

An important development of the paradigm has been done by the inclusion of the learning strategy concept. Goldman (1972) was able to show that the choice of a logical or a mnemonic strategy affected performance on academic criteria. Hypothesing that strategies mediate the transfer from abilities to performance, he was able to show a different pattern of correlations between abilities and performance in the two strategy groups. The implications were that the mnemonic strategy placed considerable valence upon memory abilities. In the logical group the valence was placed upon syllogistic reasoning. The research also indicated that strategies may be differentially effective for performing different tasks. In a later study Goldman and Hudson (1973) showed strategy differences irrespective of abilities between science and non-science groups, formal reasoning being more important in science. The results from this line of research are by no means consistent (cf Biggs 1970, Biggs 1973) but they indicate that different tasks may demand different learning strategies, which in turn may require different abilities of the learner. Recent research seems to indicate, however, that learning strategies (or level of processing) may be heavily influenced by the teacher's method of presenting material (Dahlgren, 1975).

3.1.3 Some comments on the preceding paradigms

The need for a theory. Common to both paradigms is the taxonomic and structural approach to the study of learning tasks. In the ability-skill paradigm tasks are studied and

classified with reference to composite abilities. In the ATI paradigm tasks are studied and classified with reference to ability differences between learners. The model basic to both paradigms seems to be that of information processing. Abilities are treated as mediators in processing of stimuli. Referring to this type of research Glanzer (1967 p 146-148) draws attention to the fact that some sort of process theory is needed to relate data to each other. Three basic requirements of a theory are stated: 1) a theory or explanation details a series of successive events that carry the organism from one state to another, 2) it should be a specification of a process within the individual, and 3) the intra-individual process should be available to experimental manipulation. Neither research within ability-skill paradigm nor within the ATI paradigm fulfils these requirements. The necessity of a better theoretical conceptualisation of the ATI research is underscored by Gustafsson (1975 p 9) when he asserts that application of the ATI research is possible only on a theoretical level. The possibility of classifying learners who differ on ability variables to treatments differing on task variables for practical purposes still seems far away.

The limitations of the ability definition. The applicability of the research could possibly be increased if the rather static ability constructs could be transformed to process-oriented constructs meaningfully related to learning. Meeker's (1969) cognitive therapy based on Guilford's structure-of-intellect-model in which Meeker recommends training and modification of learning task in terms of intellectual factors could be an important development.

The ITPA (Illinois Test of Psycholinguistic Abilities) should also be mentioned (Rasmussen 1971). The test has been developed on the background of the following model: Type of processing (receptive, organizing, expressive) x stimuli (auditory, visual) x response (vocal, motor) x level of processing (representational, automatic). Besides the remedial diagnostic approach generated from this model tasks and teaching could be analysed in terms of the model by

studying the compatability between the teaching profile and the pupil profile with reference to the model.

Experimental research concerning the relationships between intelligence and performance with different learning paradigms shows rather consistently that low IQ is associated with 1) a generalised expectancy of failure, 2) an attention deficit, 3) a language mediation deficit, and 4) a short-term memory deficit (Clarke 1969 p 25-37, Zeaman and House 1967 p 192-217). By establishing these types of relationships the rather static ability variables may be transformed into process constructs.

3.1.4 The learning structure paradigm. Gagné (1965) identified different kinds of learning in terms of the conditions that produce them. The following varieties of learning were specified: signal learning, stimulus-response learning, chaining, verbal association, multiple discrimination, concept learning, principle learning, and problem solving. Each type of learning may, according to Gagné, be analysed in a bipartite way in terms of conditions internal to the learner (prior capabilities) and conditions external to the learner (in the learning situation). Each type of learning in Gagné's order may be thought of as a prerequisite for learning of the kind following it in the list. An important aspect of the model is that when the conditions within the individual are satisfied learning can be formulated in terms of a set of instructional prescriptions. Instruction is the arrangement of learning conditions external to the learner, taking into account previous capabilities, requirements for retention of these capabilities and the specific stimulus situation needed for the next stage of learning. Another important feature of the model is its content-oriented approach. The assumption is that the structure of knowledge in most school topics is hierarchical, implying that mastery of higher levels is dependent on mastery of prerequisites on lower levels (Gagné op cit p 153), and that the content can be analysed and structured in an hierarchical way by means of the types of learning. The logical structure of

the content is consequently matched to a psychological structure of learning. Thus careful attention must be paid to the prerequisites of learning when designing instruction and the learning task should be analysed in terms of the type of learning involved in order to locate the important task and instructional variables to be modified and manipulated.

Kilborn and Lundgren (1975) presented flow charts illustrating interconnections of different items of the comprehensive school arithmetic course (for a more detailed description see Johansson and Kilborn, 1974). These flow charts and related diagnostic tests are intended for prescriptive teaching for individual students and planning on class level. It is also intended to be used in evaluating the compatibility of the structure of teaching material and textbooks with the logical structure of the subject. In a process study now in progress the adaptation of teaching to the diagnostic level of the pupils is being studied. Preliminary results from the study, which is based on observers and tape recordings, indicate incompatability between the teaching directed towards individual pupils and their actual knowledge of mathematics (Kilborn and Lundgren op cit p 8-15). Tentatively this research shows that the analysis of teaching and learning tasks in terms of the pupils' capabilities for solving specific tasks in a hierarchical structure of knowledge is a fruitful approach. To overcome the learning problems, however, these problems have to be analysed in terms of learning. Consequently the structure of the content must be phrased in terms of psychological processes.

3.1.5 The learning process paradigm. A study by Nyborg (1970) may serve to illustrate the above point. A simple concept learning task was analysed in terms processes involved. These processes were: Association, stimulus discrimination, response differentiation, generalisation, primary stimulus generalisation, secondary stimulus generalisation and information storage. The learning of the concept may be devided in three processes: Selection, analysis and

association. Concepts, stored in memory, may be seen as coding systems activated in stimuli selection and analysis and functioning as a mediating factor. The coding processes may be verbal or nonverbal. Applying the verbal-mediational paradigm Nyborg (1971) showed that concept learning of mentally retarded subjects could be improved considerably by adequate verbalisation. The significance of this research resides in the fact that it shows how learning task variables may be systematically analysed and manipulated on the basis of a relevant characteristic of the learner (the verbal mediation deficit in retarded learners).

3.1.6 The behaviour analysis paradigm. Behaviour analysis has been an important paradigm for determining the components of tasks. It evolves from the definition of learning tasks as observable behaviours, from the reduction of these tasks to the smallest behavioural units into a developmental pattern which leads the learner in small increments to the desired behavioural outcome (Shepherd 1973 p 107). This paradigm is basic to programmed instruction, behaviour modification, and precision teaching. The general strategy of the paradigm is to present sequentially arranged sub-tasks to a target population and rearrange the sequence of sub-task means of the error distribution. Errors may also be followed by different kinds of remedial loops. This kind of behavioural analysis may be considered an important vehicle for optimalising the arrangement of tasks for a specific population of learners. The point of departure taken in this kind of task analysis is the analysis of specific bounds in the behavioural sequence, and the instructional measures aim at strengthening these specific bounds by varying the stimulus or the response. Task analysis in the sense of Gagné as mentioned above is basically an approach to understanding the structure of knowledge and consequently the pattern for learning this structure. The different steps in the general procedure of task analysis of this kind have been outlined by Shepherd (op cit p 109). These are: 1) the global or terminal task is identified and described as a behaviour, 2) the elements or sub-tasks are specified and also described as behaviours, and 3) the task elements

are arranged in a pattern or sequence. The component skills may then be defined in terms of the learning conditions of these skills. The learning conditions may be analysed on a theory level (type of learning of the component task) or on a behavioural level (types of behaviour required to perform the component task). Diagnostic inferences may then be drawn about the requirements of the learning task, and the specific task variables may be related to learning deficits and individual differences. An interesting development of general value is reported by Engelman (Shepherd op cit p 114). Studying the verbal skills required to follow teachers' directions in kindergarten and first grade, Engelman developed an assessment procedure that made it possible to decide which of the language skills required to follow directions in school a given child did or did not possess.

3.1.7 The developmental tasks paradigm. The basic assumption of this paradigm is formulated by Stephens (1973 p 57): "When a chronological framework of standard developmental sequences is provided it becomes possible not only to identify individuals who have abnormal rates of development in a particular area but also to ascertain just how far they have proceded in the sequence." Hence, tasks may be analysed in terms of the requirements they place on motor, language, social or cognitive development, and instruction may be planned accordingly. These standard-developmental sequences may be norm-referenced or theory-referenced. Norm-referenced sequences are based on empirical scaling procedures while theory-referenced sequences are based on theories of development. In the personality domain, which will be treated later, Erikson (Bischof 1970 p 573-585) analyses the psychological content of educational tasks in terms of eight epigenetic stages based on psychoanalytic theory, and in the Piagetian tradition task requirements are analysed in terms of substages of cognitive development.

The significance of the task or instructional variables resides in their contribution to the dialectical processes of assimilation and accomodation, assimilation referring mainly to the stimulus or information input and accomodation

referring to the reorganisation of cognitive structures. Learning tasks should therefore be analysed in terms of the characteristics of the pupils' sub-stage of cognitive development. This type of analysis has proved its prescriptive value in the field of school mathematics. In a study particularly relevant here teaching materials on the secondary level were studied in terms of their demands on cognitive development. It was concluded that 70-80% of the pupils on this level had not reached developmental levels required to grip great parts of the teaching in physics (Andersson 1973). It should probably be mentioned that recent research shows that cognitive structures and the level of intellectual processing may be influenced by the traditional monitoring of the educational system (Säljö 1975 p 127). Cognitive outcomes of learning thus seem to be determinded partly by the learners perception of evaluative criteria. This fact calls for a multidimensional approach to the analysis of the requirements of learning tasks taking into consideration all relevant aspects of learning.

3.2 Personality-oriented paradigms

3.2.1 The success-failure paradigm. The basic assumptions underlying this paradigm in which the subject is made to feel he has failed or is personally inadequate have been outlined by Wylie (1961 p 184): "1. The level of self-regard is learned through a combination of rewards and punishments for one's actions and self characteristics. The person learns something about himself through success or failure in manipulation of the physical environment, and some things from the reactions of others to him. 2. A person's level of self-regard is of great importance in predicting his behaviour". Programmatic research within this paradigm has been done by Diggory (1966). Important task variables located in this research are initial expectancies of task performance, deadlines, and goals. Deadlines are time constraints which are imposed on attempts to show competency or instrumentality at some skill. Goals are important in two ways. They may be positively or negatively related to

the ability or earlier experience of the person, and they usually set some minimum standard of success to be achieved. The learner's subjective conception of the task in terms of perceived probality of success is high when a deadline is distant and vaguely located, when rates of improvement are large, and when the difference between performance and goals is small. An important outcome of this kind of task interaction is the learner's perception of abilities specific to the task at hand which seems to generalise to other abilities. This type of research shows clearly that the requirements of learning tasks ought to be put in a personal and phenomenological frame of reference.

3.2.2 The approach-avoidance paradigm. The basic assumption of this paradigm is that behaviour is purposive and that values are assigned to objects and acts. Thus certain acts are selected for and certain acts are selected against the criterion of selection being whatever promotes success in achieving the condition for terminating the purposive behaviour. According to McClelland (cf Rand 1965 p 12) we may predict two different tendencies: a tendency to seek (approach) success and a tendency to avoid failure. This expectancy variable is logically dependent upon the difficulty level of the task: "the harder the task, the lower the probability of success (expectancy of success) and at the same time, the higher the probability of failure (expectancy of failure). The three key concepts of Atkinson's theorising are: motive, expectancy and incentive. Motivation includes all the three of them as motivation is the function of a motive and an expectancy of a certain incentive it refers to a manifest state of the organism at a certain time. Motive, on the other hand, refers to a latent disposition which may be aroused by the appropriate cues, engaging the learner in an expectation of a certain incentive. Consequently, tasks may be analysed in terms of their approach avoidance values taking into consideration the learners' subjective probability of success or failure and the incentive value of the specific task (cf Rand op cit p 19-21).

3.2.3 The anxiety-task paradigm. Experimental research within this paradigm has been undertaken under somewhat different theoretical assumptions. "The test anxiety tradition" is to a certain extent compatible with approaches described earlier. Two types of responses to high anxiety levels are sorted out. These responses are acquired in earlier experience as a means of reducing anxiety. Responses of one of these two types are directed towards task completion while responses of the other type are irrelevant to the task and may interfere with task completion. In another line of research, the Hullian assertion that drives multiply habits and affects performance has been the basic assumption. The development of reasonably valid measuring instruments has made it possible for this research to be extended to school research. Some results from this research relevant to task analysis should be mentioned:

1) There are indications of an interaction between the anxiety level of the learner and the complexity of the task in such a way that low anxiety learners do better on complex tasks and high anxiety learners do better on simple tasks (Cofer and Appley 1964 p 706-707).
2) These are also indications that high anxiety learners respond to evaluations of task performance (experimentally induced success and failure) with responses that interfere with performance (Cofer and Appley op cit p 711-712).

Research in education on the differential effects of structured and unstructured programs on pupils differing in anxiety support to some extent the experimental research. These results indicate that anxious or defensive pupils "will learn most if the teacher spells out short-term goals, gives a maximum of explanation and guidance, arranges feed-back at short intervals to keep the pupil from setting off the track ..." (Cronbach 1967 p 35). These measures may have two possible effects: They reduce the anxiety level of the learner and/or they reduce the complexity of the task.

3.2.4 The locus of control paradigm. According to the social learning theory of Rotter (1954) a distinction is made between two sources of reinforcement. When reinforcements are contingent actions these may be regarded as results of one's own actions or abilities (internal locus of control) or they may be regarded as results of outside forces (external locus of control) such as fate, chance or powerful others. Experimental research within this orientation indicates that 1) failure experiences affect children with external locus of control most negatively, 2) task persistence is enchanced through a belief in personal responsibility and a belief that success or failure are related to one's own effort, and 3) that children with external locus of control work more persistently at tasks when they perceive results as dependent upon chance, while children with internal locus of control show more persistence when they perceive their results as dependent upon skill (cf Lawrence and Winschel 1975).

In mental retardation research the locus of control problem has been termed inner- versus outer-directedness. Outer-directedness is regarded as a style of problem-solving generated by the high-incidence of failure experienced by mentally retarded pupils. The mentally retarded person distrusts his own solutions to problems and therefore seeks guides to action in the immediate environment (cf Zigler 1966 p 99-103). Outer-directedness reflects in this way not an inherent characteristic of the individual, but a style of problem-solving emanating from the experiential histories of these children.

4 A SUMMARY OF PARADIGMS AND SOME TENTATIVE IMPLICATIONS

4.1 Cognitive-oriented paradigms

The ability-skill paradigm. Attempts to determine the components underlying performance where a skill is involved and the introduction of the time factor imply the

following:

1) task requirements should be analysed in terms of intellectual abilities of the learner or in terms of learning factors required to perform tasks, and

2) a process-oriented approach to task performance should be taken, in which the differential requirements of the skill structure, the cumulative changes of the task with practice and the effects of these changes on the ability and learning potential of the learner are stressed.

The ATI paradigm. Attempts to locate the important correlations between a set of instructional variables and a set of individual variables underscored the multidimensional character of the learner-task interactions and the difficulties met in formulating instructional decisions in terms of individual differences. However, the research efforts indicate 1) the necessity to determine the preferential instructional mode of specific learning tasks in a specific group of learners, and 2) the necessity to decide which instructional measure should be taken (remedial, compensatory or preferential).

The learning structure paradigm. Attempts to relate tasks to an integrated structure of knowledge which, in turn, was analysed as a hierarchial learning structure consisting of different varieties of learning, may give the following implications:

1) The logical structure of the teaching content should be worked out whenever possible.

2) Tasks should be analysed in terms of the requirements they place on the prior knowledge of the learner and in terms of their significance for subsequent learning, and

3) Tasks should be analysed in terms of the learning problems inherent in the task in order to specify the prerequisite conditions for the learner and the instruction conditions for fostering a specific type of learning.

The learning process paradigm. This paradigm has much in common with the preceding one. However, its basic purpose is to uncover the types of learning which are implicit in the task. The important implications are:

1) Tasks should be analysed in terms of the learning processes involved in performance.
2) The learning problems of the group of learners should be specified in relation to the learning processes involved in task performance.
3) Teaching should be based systematically on the preceding analyses.

The behaviour analysis paradigm. The necessity of describing the learning task in behavioural terms is emphasized. When the behavioural description is given

1) it is possible to sort out the difficult steps in the behavioural sequence, and
2) it is possible to take measures to change the requirements of the task for the learner by changing the behavioural sequence through compensatory or by remedial training.

The development tasks paradigm. In this paradigm the requirements of tasks are analysed in terms of standard developmental sequences or in terms of what is ordinarily accomplished by learners on a specific age level. Important educational implications may be sorted out by relating tasks to developmental stages and processes inferred from developmental theories.

4.2 Personality-oriented paradigms

Three paradigms were outlined. All three underscored the importance of considering the learner's subjective conceptualisation of task requirements and the teleological character of human behaviour.

The success-failure paradigm. According to this paradigm self-evaluation is an effect of instrumental task performance, the criteria of evaluation being the experience of success or failure. The implications of this kind of research seem to be:

1) the initial expectancy of the learner in terms of success or failure or subjective perception of ability should be plotted when new tasks are introduced, and

2) task variables as goal levels, time constraints, and feed-back should be manipulated.

The approach-avoidance paradigm. In this paradigm tasks were analysed in terms of their incentive values produced by specific task cues. The incentive value associated with specific task cues may be an expectancy of failure resulting in avoidance behaviour or an expectancy of success resulting in approach behaviour. The important indications seem to be:

1) the task-relevant cues should be sorted out by analysing the avoidance behaviour of the learner, and

2) the complexity of the task should be reduced.

The anxiety-task paradigm. In the study of positive and negative interference of anxiety on task performance, the detrimental effects of anxiety seem to be greatest in performing complex tasks. The implications of the research were that perceived complexity could be manipulated by the definition of short-term goals, frequent feed-back, explanation and guidance.

The locus of control paradigm. Research within this paradigm shows 1) that the individual´s style of problem solving is an important parameter of the learner-task interaction affecting reactions to failure experiences as well as persistence at tasks and 2) that this problem-solving style is a function of patterns of feed-back and reinforcement in the environment of the individual.

5 TASK DIMENSIONS RELEVANT TO THE ANALYSIS OF TEACHING AND LEARNING

Taking as the point of departure the assumption that the task confronting pupils and teachers should be the basic unit of analysis of education, the research paradigms or strategies utilised in empirical research were scrutinized to specify dimensions of tasks relevant to the learning process. The analyses showed rather clearly that the learner's subjective perception of the task at hand was an important parameter in determining the requirements of the task as well as the learning outcome. Hence, the dimensions relevant to learner-task interaction should be studied on a perceptual as well as on a behavioural level. Task dimensions considered relevant in the different paradigms are listed below, the list being by no means complete. The interactive character of the dimensions is also underscored.

5.1 Goals

On the behavioural level the term "goals" refers to terminal behaviours, knowledge or attitudes. On the perceptual level the term refers to what the learner experiences as the goal, his perception in terms of vagueness of goal, relevance of goal, and distance to goal.

5.2 Feed-back and the criteria of evaluation

On the behavioural level "feed-back" refers to types of monitoring in learner-task interaction. Feed-back may be directly related to task interaction as in motor learning (swimming, cycling) or it may be related to person interaction as in most school subjects. On the behavioural level the evaluative criteria may be inferred from the way the learner is monitored by other people during learning, or by the ways the outcomes of learning are evaluated (type of test items). On the perceptual level feed-back is perceived in terms of evaluative criteria. The learner's perception of these criteria determine what

he perceives as the important outcome of the learner-task interaction and how he perceives his own instrumentality in relation to these outcomes.

5 3 Structure

The structural aspects of the task may be described in terms of prerequisite knowledge, learning types, developmental requirements or modality channels. On the behavioural level tasks may be described in terms of their position in a logical structure of knowledge and the prerequisites for performing the task, or tasks may be described in terms of hierarchical structures of learning and development and the learning or developmental dimensions of the tasks may be inferred. Finally, tasks may be described in terms of ability components and their preferred modes of instruction. Knowledge of the structural dimensions of tasks permits systematic collection of diagnostic information concerning the individual learners, and description of optimal learning, developmental, and instructional conditions of the task. On the perceptual level structure refers to the learner's perception of prerequisite knowledge for performing the specific task at hand, the subjective meaning of the task in relation to developmental level, and his specific abilities for performing the task.

5.4 Complexity

Complexity refers to the evaluation of the structure of the task. On the behavioural level complexity may be inferred from the structural dimensions of the task in terms of demands for complex knowledge, learning type or developmental requirements, and in terms of the objective abilities, knowledge and developmental characteristics of the learner. On the perceptual level complexity refers to the learner's perception of his own abilities for performing the task, which are consequences of prior learning experiences.

5.5 Time constraints

On the behavioural level the time constraints refer to the time available for performing a task up to a required level of proficiency. On the perceptual level time constraints refer to the subjective experience of the time available. This experience is among others a product of the perception of abilities for performing the task and the perception of task complexity.

5.6 Incentive value

On the behavioural level the incentive value of a specific task may be analysed in terms of the approach or avoidance behaviour of the learner. On the perceptual level the incentive value of the task is the perceived arousal of success-failure expectancies.

5.7 Conclusions

The preliminary conclusions to be drawn from the analysis are:

1) Learning should be analysed in terms of a set of interacting task dimensions.
2) The importance of the perceptual and experential aspects of the learner-task interaction in determining the outcome of a learning situation should be emphasized, and
3) The demands on the learner should be analysed in a multidimensional way.

6 SOME GENERAL IMPLICATIONS FOR THE STUDY OF PEDAGOGICAL PROCESSES

In previous parts of this paper a learning oriented approach to education has been proposed. This approach relates learning to a set of task dimensions (goals, feed-back, structure, complexity, time constraints, and incentive

value). It has been asserted that the task dimensions should be interpreted both at a behavioural level and at a perceptual level. It has been further asserted that the outcomes of learning could be analysed in the context of these interacting task dimensions. Assuming that the legitimate aim of education is to design classroom environments conductive to learning, it is further proposed that teaching processes should be evaluated according to how well they are designed to control the learning-relevant task dimensions. However, teaching cannot be analysed solely in terms of its ideal aims. We shall therefore have to include the internal and external conditions of teaching. These conditions, however, are to a considerable extent determined by conditions outside the school system itself. Hence, a proper analysis of the learning-teaching process should be extended to the society at large in which this process takes place.

The holistic, relational and generative character of pedagogical processes have also been pointed out. To preserve a holistic conception of the pedagogical process, connections between different levels of analysis must be made clear. Educational problems may be analysed at least three levels. On the micro level the specific content of the educational process in terms of dimensions relevant to the process of learning is studied. The micro analysis takes its point of departure in the study of the task-learner interaction. Most of the experimental research reviewed here has been conducted on this level. Because of the purification of the context of learning in this type of research the applicability of its outcomes is extremely limited. Analysis on this level has therefore to be integrated with analyses on other levels.

The classroom is the context of the task-learner interaction in school learning. Hence, the analysis on the intermediate level takes its point of departure in school variables related to task-learner interactions. The purpose of the analysis is to specify the relationship between the learning-relevant task dimensions (goals, feed-back, evaluative criteria, task structure, complexity, and incentive value)

and school variables. It should be pointed out, however, that school variables are not identical with teaching variables. The purpose of teaching is to design situations conducive to learning of a planned and predicted kind. Thus, teaching variables refer to the ways the learning-relevant task dimensions are controlled and manipulated in the context of the classroom. School variables, on the other hand, refer to a broader group of variables. These also include variables activated in the school setting which affect the learner-task interaction in unplanned ways.

The distinction between manifest and latent functions of schools is relevant here. This distinction brings out the fact that outcomes of the teaching-learning process, even if they are not legitimately verbalised in terms of goals, may be related to social and political processes in society at large.

The conditions of the learner-task interaction expressed at the intermediate level are, as pointed out earlier, determined largely on the macro level, i.e., outside the school itself. These outside influences may affect the learner-task interaction directly in terms of goals and curriculae. They may also be transmitted indirectly in terms of frames affecting the conditions of the learner-task interaction and they may be transmitted to the learner-task interaction in terms of values.

When pedagogical processes are conceived of in a holistic frame of reference their relational character becomes evident. Research on the micro level demonstrates clearly that the way the learning problem is presented affects pupils differently depending upon their different abilities and previous experiences. Thus, selection of methods of presentation as well as organisation of teaching are proper units of analysis from a relational point of view. As it soon becomes evident that selection of methods as well as organisation of teaching are to a considerable extent dependent upon and defined by conditions external to the teaching situation itself, the relational as well as the total character of teaching is

substantiated.

Thus, since particular pedagogical phenomena must be understood in the total context of society, the basic tenets of critical theory (cf Kalleberg 1970) may be successfully applied to the analysis of pedagogical processes. From a practical point of view the objectification of school problems in terms of individual abilities and behaviours, on which present strategies within school organisation are based, is incompatible with the total and relational conception. However, it could be an important objective of educational research to work to reinstate an integrated conception of pedagogical processes.

The generative aspect of teaching should also be considered. The term generative is used to imply that the classroom and teaching processes observed and the school problems associated with them may be implicit in the selection of content and teaching material, in the ways in which the school is organised, and in the functions of teaching. From a generative point of view these factors may be treated as restrictions which serve to structure pedagogical processes as well as they affect values and goal-setting behaviours of the agents of these processes. In vocational schools, the pedagogical processes and the problems associated with them may be understood on the micro level in terms of the tasks confronting pupils in these schools when they are trained to produce objects and systems by means of machines, material and tools. The structure of the school environment as well as the nature of the processes in which these objectives are to be fulfilled restrict and define the amount and type of pupil-pupil and teacher-pupil interactions during learning. An additional factor on the macro level which may directly affect pedagogical processes in vocational education is the cost of such education. For example, the number of machines available is usually less than the number of pupils, creating a need for efficiency in the learning situation which may lead to certain problems. Finally, because of the selective character of the school system and the values of society with regard to theoretical and practical schooling, vocational

training may be regarded as the lower "stream". This may create a certain degree of homogeneity in this group regarding school experiences and attitudes to schooling.

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